Irrigated Lands Regulatory Program
Slope Reporting Requirements
Guidance Document

September 2021

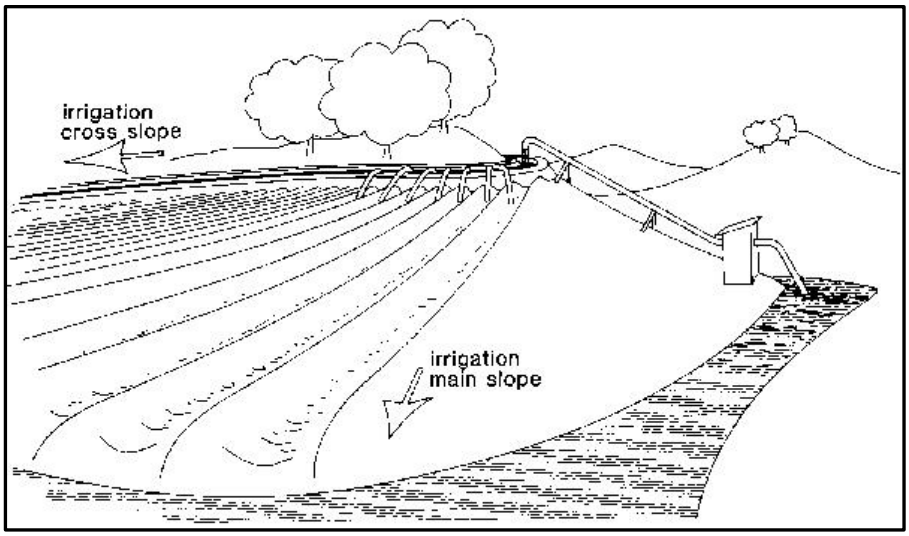
Reporting Requirement

The purpose of the percent slope reporting requirement on the eNOI is to gather information on ranch general characteristics and potential risk to water quality. There are no additional requirements in the Agricultural Order based on the slope of a ranch. The following is a general summary of the eNOI reporting requirement guidance:

- The highest (maximum) slope value calculated must be reported on the eNOI.
- The percent slope is the relationship between the amount of elevation rise or drop over a horizontal distance.
- Slope should be calculated based on current site conditions on the ranch.
- Slope should only be calculated for irrigated crop acreage.
- Slope measurements should not be made across stream beds, multiple watersheds, or other natural features that disrupt a continuous slope of irrigated land. As such, slope measurement across the entirety of a field or ranch may or may not be appropriate.
- The slope of levees, terraced banks, or benches should not be included in the calculations.

Definition of Slope

Slope is the degree of upward or downward slant or inclination. A slope is the rise or fall of the land surface.



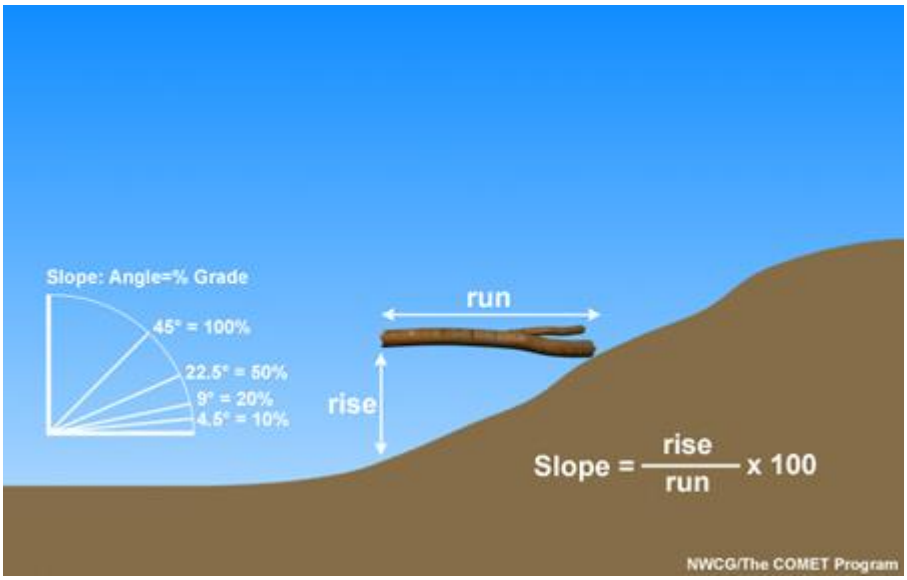
Source: Food and Agriculture Organization of the United Nations (FAO), Chapter 3, Elements of Topography, Slope Definition, n.d., retrieved on 09/07/2021 from the FAO website.

Slope Formula

The percent slope is the relationship between the amount of elevation rise or drop over a horizontal distance, expressed as the equation:

Percent Slope = Rise (change in elevation) /Run (distance in feet) x 100

How to Measure Slope



Source: National Wildfire Coordinating Group (NWCG), Slope, n.d., retrieved on 09/07/2021 from NWCG website.

Mapping Tools

The following mapping tools are acceptable for use to calculate maximum slope for the irrigated acres on any given ranch.

Contour Maps

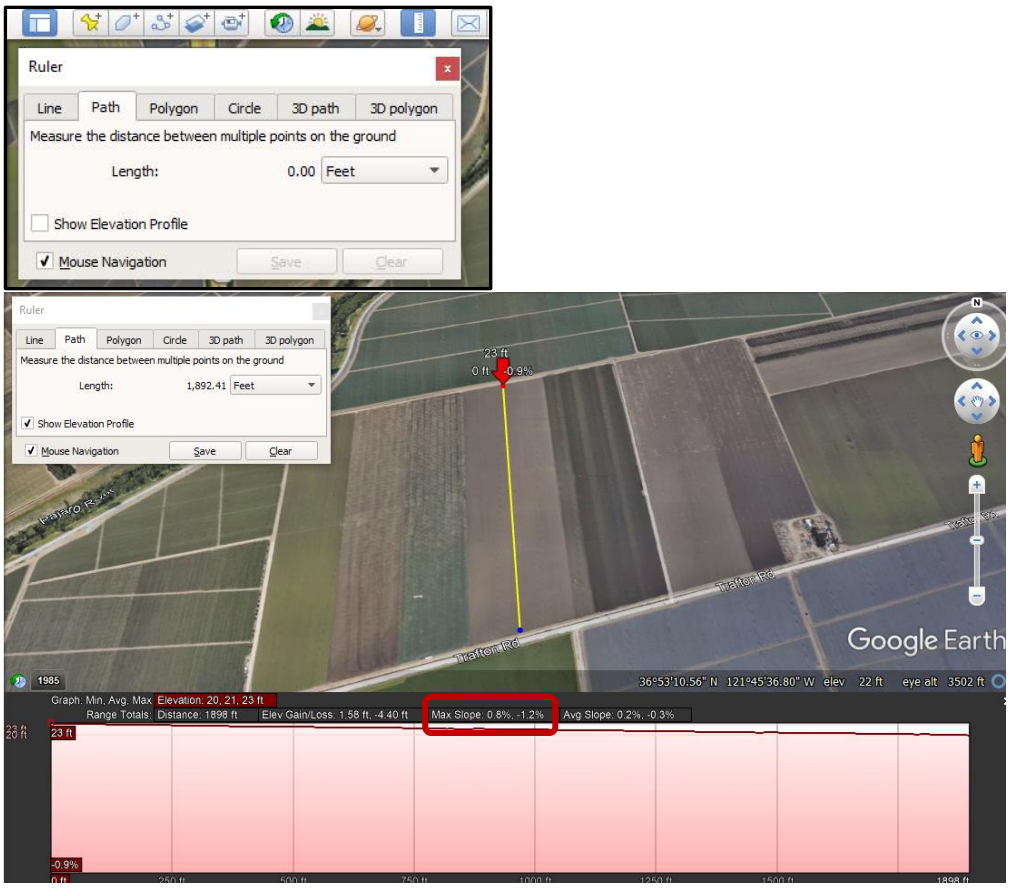
Contour maps are publicly available and can be downloaded free of charge through the U.S. Geological Survey National Map Data Delivery website. The website also has a training link with videos on using the map products and services, a help section, and frequently asked questions section. Forest Measurements (Joan DeYoung) provides a Tips for Measuring Percent Slope on Contour Maps.

Google Earth Pro

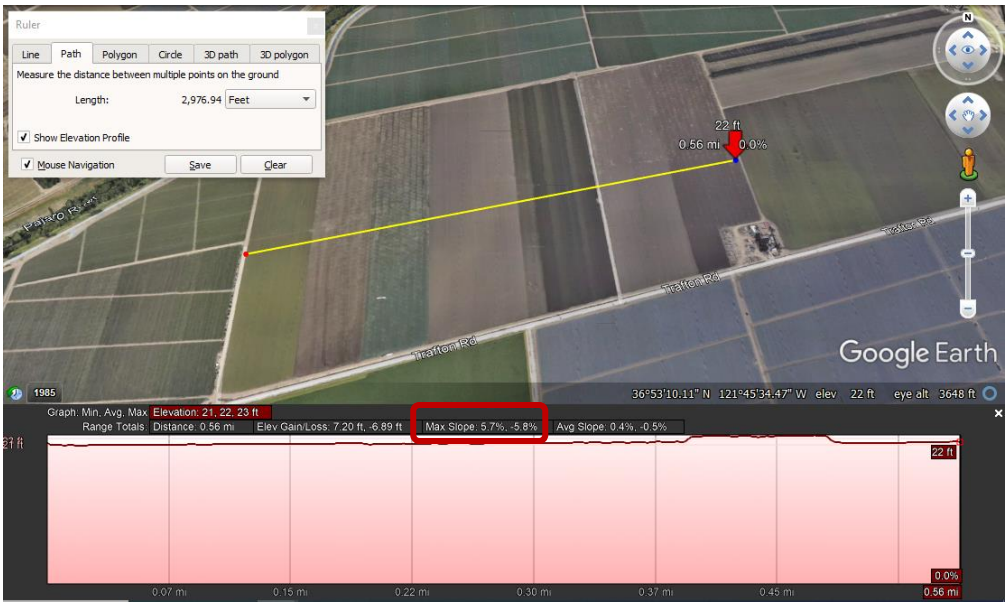
Google Earth Pro is free, web-based mapping tool that includes a function to measure distance and elevation and calculates maximum and average slopes. The "Ruler" function allows the user to easily calculate the maximum slope on a computer.

"Draw" a line across the landscape which calculates distance. Using the "Path" feature in the ruler and clicking on the "Show Elevation Profile" box. Google Earth Pro is can only accurately calculate slope for distances greater than 100 feet. See the example below and description of what to report and see additional examples of slope measurement using Google Earth Pro in Appendix 1 to this guidance document.

The measurement tool in Google Earth Pro does all the calculations. There is no need to use the slope formula.



In this example, the maximum slope is 1.2%. The line should also be drawn horizontally to identify that is the maximum slope for the entire ranch.



In this example, the maximum slope is 5.8% **Report the maximum slope for the ranch as 5.8% (the greater of the two measurements).**

Field Measurement Tools

There are numerous hand-held tools that can be used in the field to measure slope: clinometers, levels, etc. There are also more sophisticated hand-held devices: GPS, precision altimeters, digital levels, electronic protractors, laser rangefinders, etc. There are also inclinometer apps for android and apple cellular phones but be sure to review the accuracy; some are very accurate, others are not. The more commonly used and least expensive tools are discussed below.

Abney Level

This hand-held instrument used since the late 1800s for backcountry surveying. To measure slope, set the protractor mounted on the side of the level with the appropriate scale to a fixed gradient. Next, sight through the Abney to a fixed reference (usually another person) until a bubble appears in the crosshair. When the crosshair bisects the bubble, you've reached the preset grade on the Abney. The Abney has been replaced in recent decades by the clinometer. (Schmid, J., Trail Tools: Survey, Layout, and Measuring Tools, American Trails, n.d., retrieved on 09/07/2021 from the American Trails website).

Clinometers

A clinometer can be used to measure soil slope between two points. It has a small hole used to read the soil slope in degrees scale and the equivalent in percent scale. It has a floating scale internally from which a slope is measured. Hold the clinometer to your eye and with both eyes open, sight parallel with the ground (upslope or downslope) to a target (stick or someone your own height), aiming at a point on the target that is equal to the height of your eye above the ground. Read directly from the percent scale. Percent slope is the relationship between the amount of elevational rise or drop over a horizonal distance. (Schmid, J., Trail Tools: Survey, Layout, and Measuring Tools, American Trails, n.d., retrieved on 09/07/2021 from the American Trails website). Forest Measurements (Joan DeYoung) provides an overview of the use of a clinometer to calculate slope: Assessing the Slope of the Land and Field Technique Tips for Measuring Slope. (DeYoung, J., Forest Measurements, n.d., retrieved from the Open Oregon Pressbooks website).

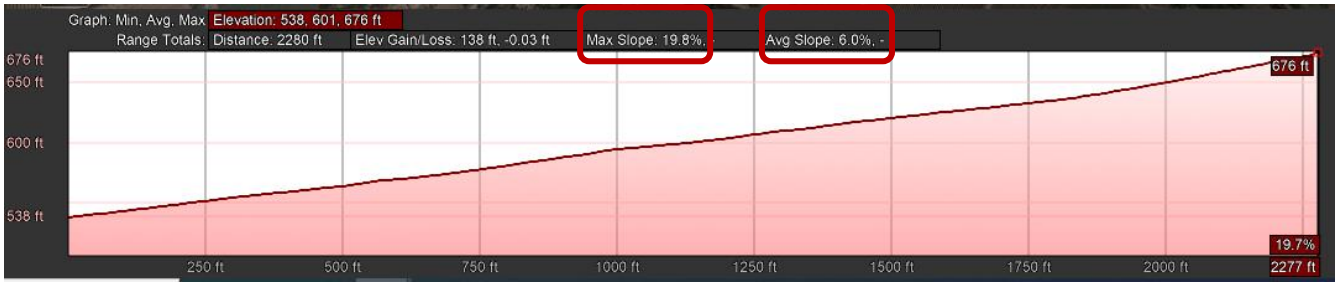
Measuring Wheel

The measuring wheel is used to measure distance. It records the revolutions of a wheel and hence the distance traveled by the wheel. Measuring wheels can be used to measure distance for calculation of slope and then using a clinometer to calculate the rise. Combined, these give an accurate measurement of the slope between two points. (Schmid, J., Trail Tools: Survey, Layout, and Measuring Tools, American Trails, n.d., retrieved on 09/07/2021 from the American Trails website).

Appendix 1: Google Earth Pro Examples

Example 1

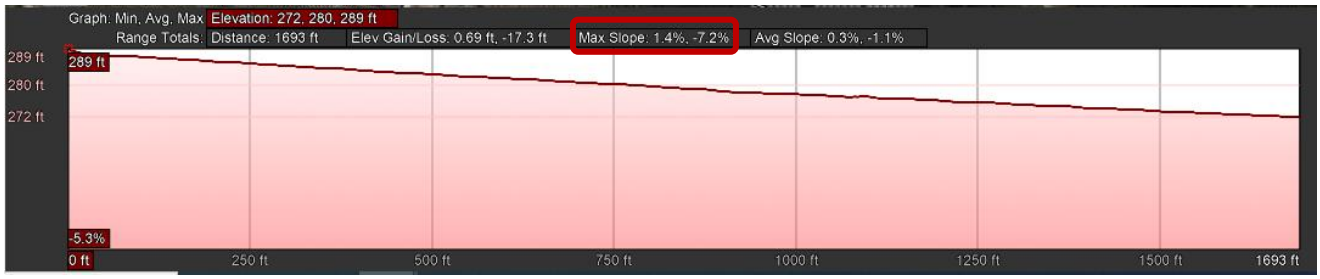
This information should not be used for reporting purposes. Use the elevation profile shown below.



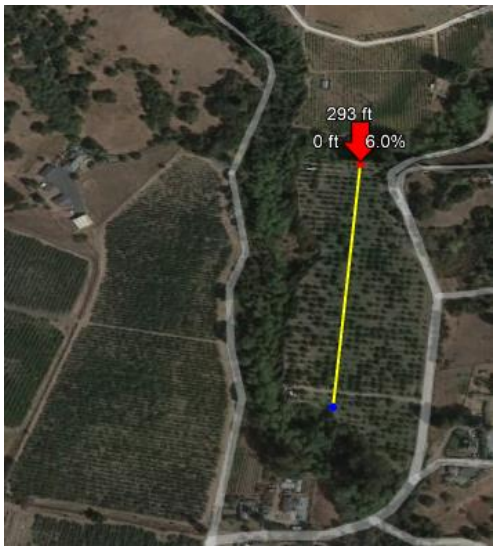
- Google Earth Pro calculates the maximum slope as 19.8%.
- With the line drawn across the entire ranch, the formula is going to calculate the average slope (676 – 538 / 2280 = .06 x 100 = 6%), not the maximum slope.
- **Report the maximum slope for the ranch as 19.8%.**

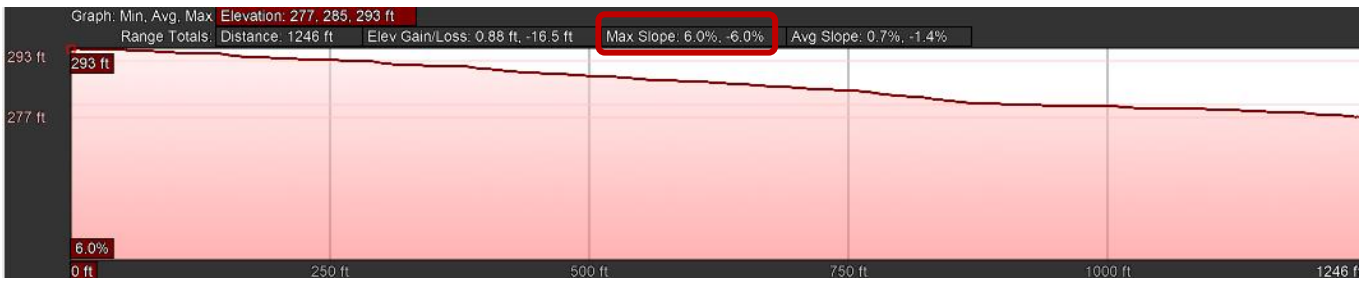
Example 2

Depicting a ranch divided by non-irrigated lands. Non-irrigated acreage should not be included in the measurement. Draw separate lines for the left and right sections (see images below). Report the maximum slope for whichever of the two ranch segments has the highest slope.



- Maximum slope for this segment is 7.2%



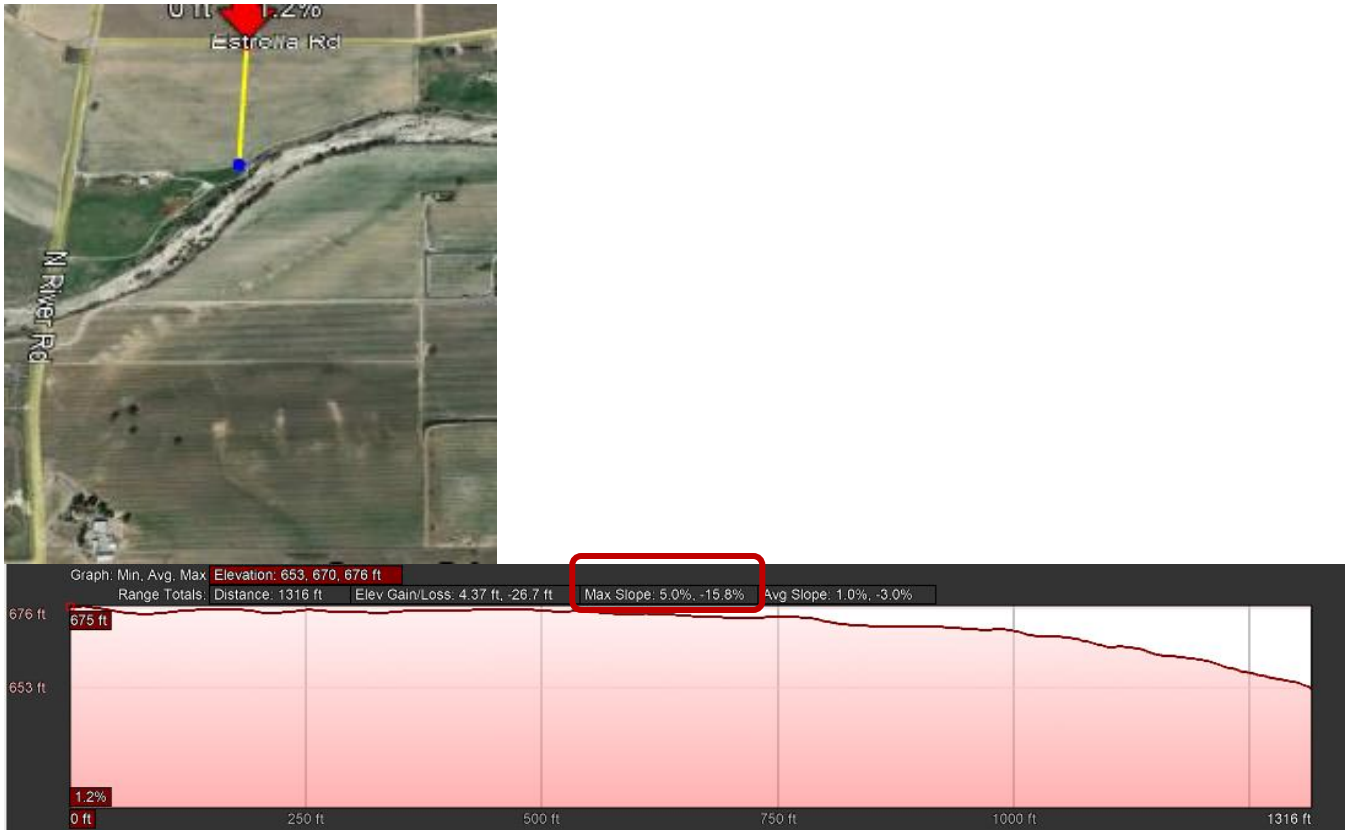


- Maximum slope for this segment is 6%
- **Report the maximum slope for the ranch as 7.2%.**

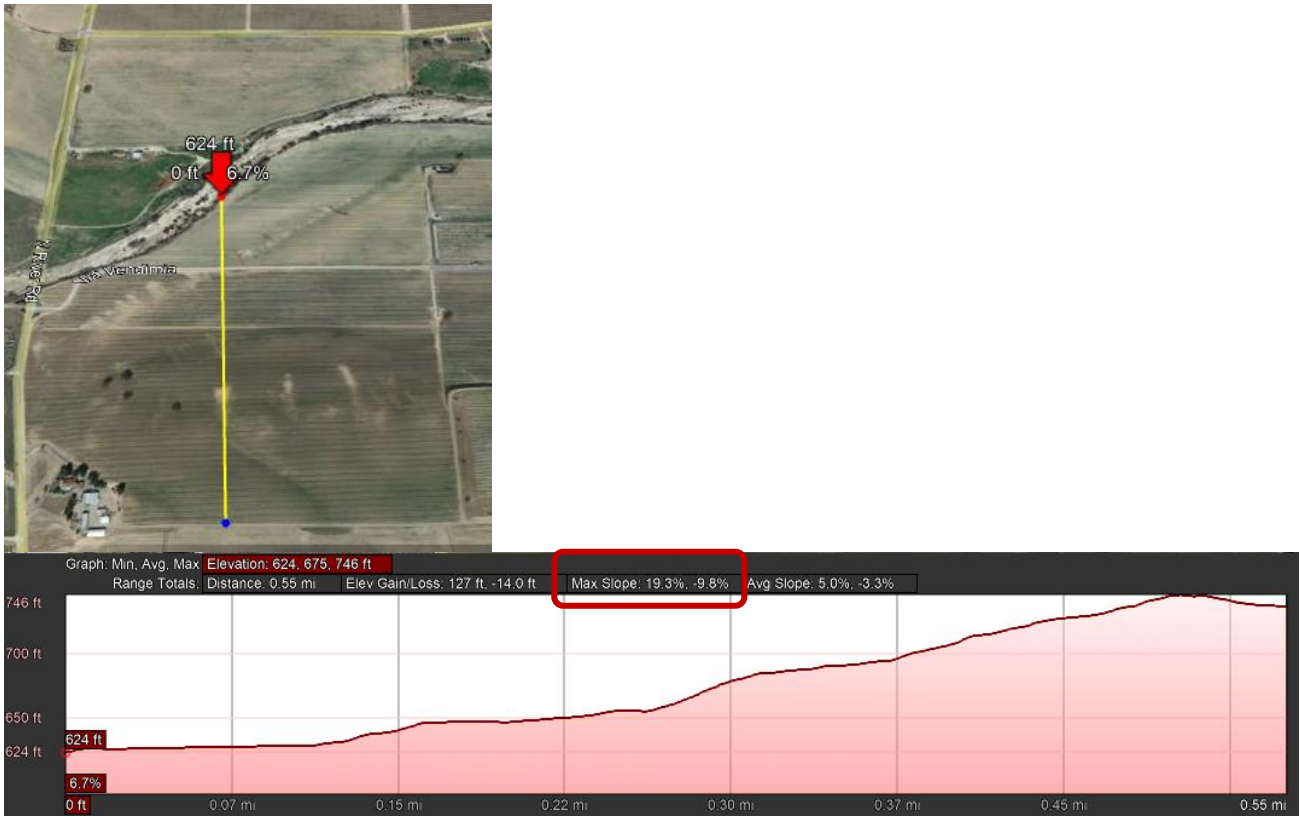
Example 3

Depicting a large ranch divided by a waterbody and parcel with non-irrigated acreage.

- In the image on the left, the line is drawn improperly because it includes a waterbody channel, as well as areas that are not irrigated acreage. In the image on the right, the line is still drawn improperly because it includes a waterbody channel. The same would apply if the ranch covered two watersheds.
- Draw lines in segments to include only irrigated acreage and exclude waterbody channels (see images below).



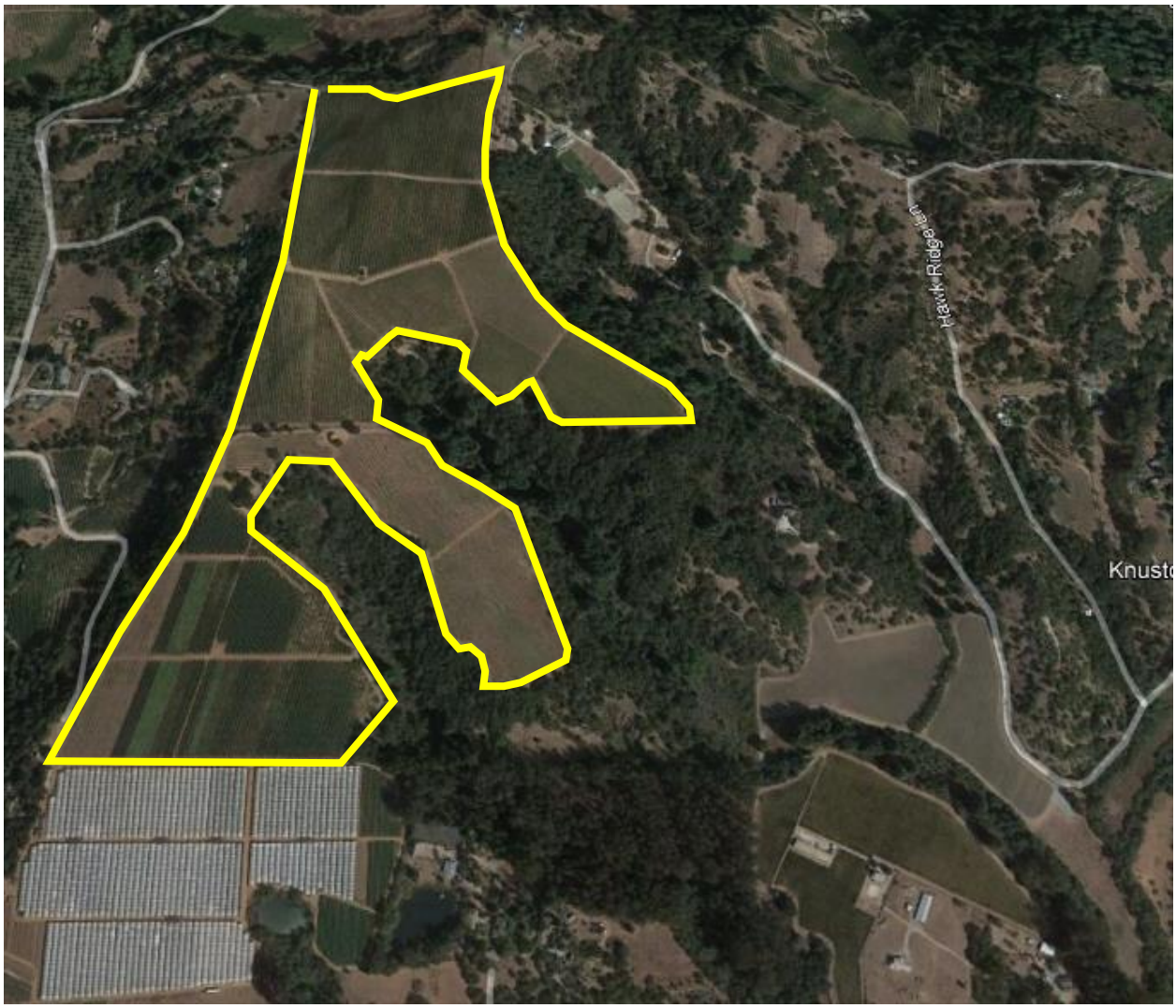
- Maximum slope for this segment is 15.8%



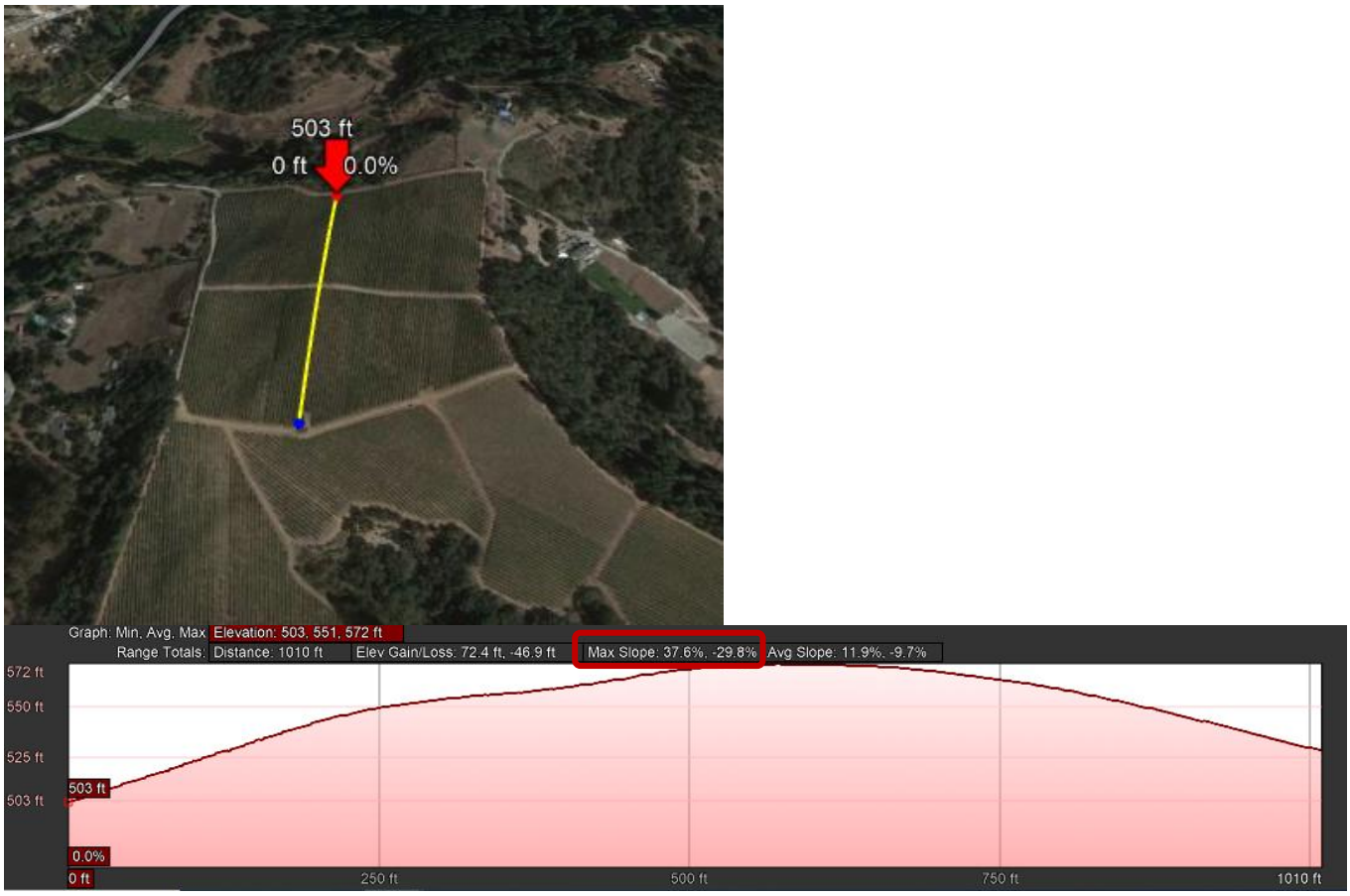
- Maximum slope for this segment is 19.3%.
- **Report the maximum slope for the ranch as 19.3%.**

Example 4

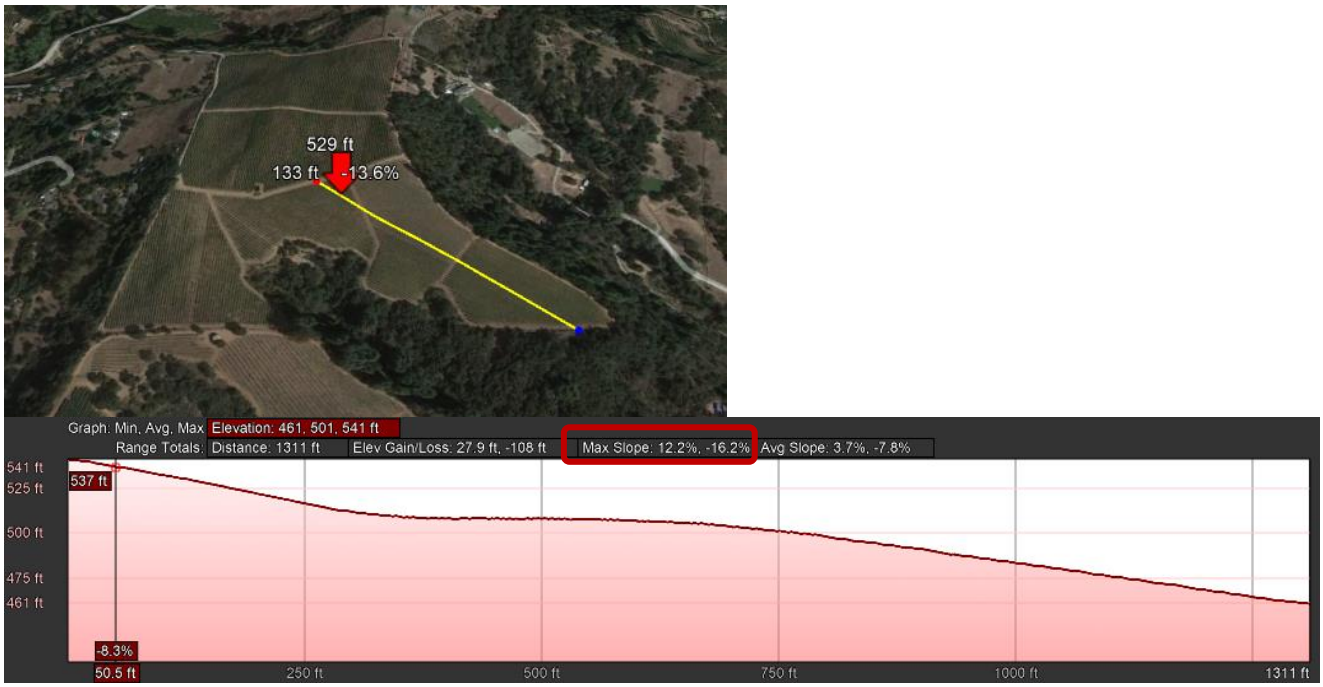
Depicting a ranch with “fingers”.



- Measure segments of the ranch as depicted in images below.



- Maximum slope for this segment is 37.6%



- Maximum slope for this segment is 16.2%

- Maximum slope for this segment is 14.2%

- Maximum slope for this segment is 24.4%

- Maximum slope for this segment is 20.3%
- **Report the maximum slope for the ranch as 37.6%.**